HRSD SWIFT Research Center (SWIFTRC) Quarterly Report on SWIFT Water Quality Targets

This report documents SWIFT Water Quality results for recharge operations from July 1 – September 30, 2019. The compliance requirements are documented in HRSD's SWIFT Underground Injection Control Inventory Information Package (UIC-IIP) submitted to EPA Region III in January 2018. These requirements are noted in the following tables (Tables 1-4), extracted from Attachment B of the UIC-IIP. Figures 1 and 2 and Table 6 provide the data from the second quarter of operations relative to these SWIFT Water Quality Targets. Table 6 is a new addition to the quarterly report and represents a summary of all analytes that were present above the laboratory reporting limit. The detailed table identifying all of the parameters monitored for the purpose of evaluating compliance with the SWIFT Water Quality Targets can be found as an Appendix to this report.

Parameter	Proposed Regulatory Limit	Non-Regulatory Action/Goal
EPA Drinking Water Primary Maximum Contaminant Levels (MCLs)	Meet all primary MCLs	N/A
Total Nitrogen	5 mg/L Monthly Average; 8 mg/L Max Daily	Secondary Effluent Critical Control Point (CCP) Action Limit for Total Inorganic Nitrogen (TIN) = 5 mg/L-N; CCP Action Limit for SWIFT Water Total Nitrogen (TN) = 5 mg/L-N
Turbidity	Individual Filter Effluent (IFE) < 0.15 NTU 95% of time and never >0.3 NTU in two consecutive 15 min measurements	CCP Action Limit IFE of 0.10 NTU to initiate backwash or place a filter in standby
Total Organic Carbon (TOC)[1]	4 mg/L Monthly Average 6 mg/L Maximum	Critical Operating Point (COP) Action Limit to Initiate GAC Regeneration
Total Coliform	<2 CFU/100 mL 95% of time; Not to exceed geometric mean of 3 CFU/100 mL, based on a running calculation of 20 days of daily samples for total coliforms	N/A
E.coli	Non-detect	N/A
TDS[2]	N/A	Monitor PAS Compatibility

Table 1: SWIFTRC Regulatory and Monitoring Limits for SWIFT Water

[1] Regulatory limit applies to the TOC laboratory analysis which is collected at a frequency of 3 times per week.

[2] No limit for TDS proposed as the primary driver is aquifer compatibility. The concentration of SWIFT Water at the SWIFTRC generally ranges from 500-850 mg/L.

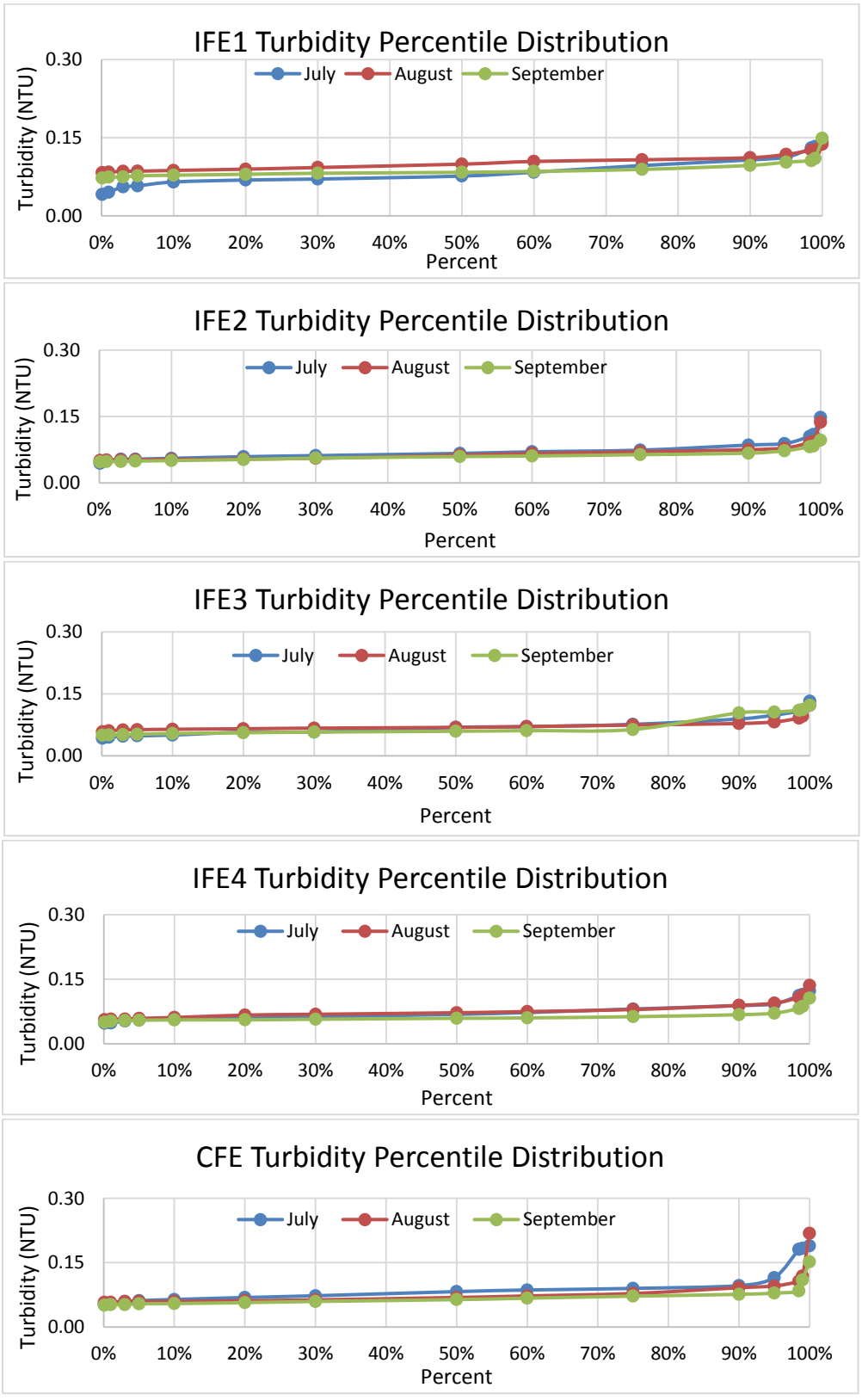

Figure 1: Percentile distribution of 15-minute average Individual Filter Effluent (IFE) Turbidities for Biofilters 1-4 (IFE1-4) and Combined Filter Effluent (CFE). There were no 15-minute periods in this quarter with biofilter effluent turbidity values greater than 0.3 NTU. The 95% measured value for each biofilter IFE and the CFE was less than 0.15 NTU for each month in this quarter.

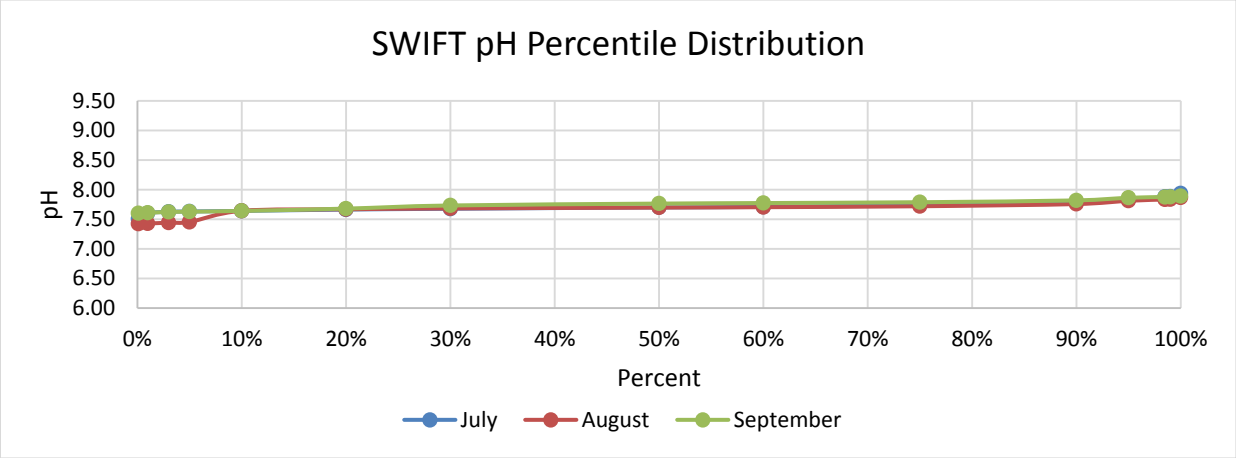

Figure 2: Distribution of Monthly SWIFT Water pH values.

Monitoring at the SWIFTRC also includes monitoring for performance indicators as documented in Table 2, extracted from Attachment B of the UIC-IIP.

Constituent	Category	Value	Unit	Notes
1,4-Dioxane	Public Health	1	µg/L	CCL4; CA Notification Limit
17-β-Estradiol	Public Health	TBD	ng/L range	CCL4
DEET	Public Health	200	µg/L	MN Health Guidance Value
Ethinyl Estradiol	Public Health	TBD	ng/L range	CCL4
NDMA	Public Health	10	ng/L	CCL4; CA Notification Limit
Perchlorate	Public Health	6	µg/L	CA Notification Limit
PFOA+PFOS	Public Health	70	ng/L	CCL4; EPA Health Advisory
TCEP	Public Health	5	µg/L	MN Health Guidance Value
Cotinine	Treatment Effectiveness	1	µg/L	Surrogate for low molecular weight, partially charged cyclics
Primidone	Treatment Effectiveness	10	µg/L	
Phenytoin	Treatment Effectiveness	2	µg/L	
Meprobamate	Treatment Effectiveness	200	µg/L	High occurrence in wastewater treatment plant effluent
Atenolol	Treatment Effectiveness	4	µg/L	
Carbamazepine	Treatment Effectiveness	10	µg/L	Unique structure
Estrone	Treatment Effectiveness	320	µg/L	Surrogate for steroids
Sucralose	Treatment Effectiveness	150	mg/L	Surrogate for water soluble, uncharged chemicals with moderate molecular weight
Triclosan	Treatment Effectiveness	2,100	µg/L	Chemical of interest

TBD = to be determined

Table 2: SWIFTRC Non-Regulatory Performance Indicators

Pathogen Log Removal Value (LRV) is not strictly regulated but the SWIFTRC has been designed and is operated to achieve at least 12 LRV for viruses and 10 LRV for

Cryptosporidium and *Giardia* through a combination of advanced treatment processes and soil aquifer treatment. Table 3 provides a treatment process pathogen LRV summary for recharge conditions. Table 4 provides additional monitoring that is being completed to document compliance with the LRVs for ozone and UV.

Parameter	Floc/Sed (+BAC)	Ozone	BAC+GAC	UV	Cl2	SAT	Total
Enteric Viruses	2	0-3 (TBD)	0	4	0-4	6	12-19
Cryptosporidium	4	0	0	6	0	6	16
Giardia	2.5	0-1.5 (TBD)	0	6	0	6	14.5-16

Table 3: SWIFTRC Pathogen LRV for Potomac Aquifer System (PAS) Recharge.

Ozone LRV
Ozone Influent Temperature
Ozone Influent Flow
Liquid Phase Ozone Concentration[1]
Contact Time
CT
UV LRV
UV Intensity, each reactor
UVT, GAC Combined Effluent
Reactor Flow, each
Calculated Dose, each Lamp
Status, each

[1] The ozone liquid phase probe is verified with lab grab samples performed at least once per week.

Table 4: Additional Monitoring to Support Ozone and UV LRV. All data are collected as continuous measurements. The 15 minute LRV data is submitted in Table 6.

Critical Control Points

The SWIFTRC incorporates Critical Control Points (CCP) throughout the treatment process, per Attachment G of UIC-IIP to verify that treatment goals are being met at each of the individual processes. A violation of any CCP means that the SWIFTRC may not be producing water that meets the treatment goals and will trigger a diversion of the SWIFT Water so that it is not directed to the recharge well. In most instances, the SWIFTRC will continue to operate through the CCP violation, but the SWIFT Water will be diverted back to the Nansemond Plant chlorine contact tanks (CCT).

CCPs have alert values at which point the operator is expected to take action to correct the performance as well as the alarm values at which point an automated response will trigger action and prevent flow from going to the recharge well. Both the alert and alarm values will be measured consistently for a specified duration before action is taken so that blips in online analyzers do not trigger action. The specific values for the alert and alarm levels will be configured as adjustable set

points in the Distributed Control System (DCS) and optimized as needed to meet the water quality requirements.

Table 5 shows the current CCPs in effect at the SWIFTRC. Modifications have been made to the CCPs since startup as compared to the original design documents in order to optimize their performance. Each of these modifications from previous quarters was discussed in each of the previous reports. Additional modifications made during this period of operation are noted in the table in redline and discussed below.

- Increased the Influent Pump Station Conductivity CCP alarm value from 1,200 uS/cm to 1,500 and alert value from 1,500 uS/cm to 1,800. Conductivity is used as a surrogate for bromide. Data collected during high conductivity events at Nansemond Plant allowed us to refine the calculated relationship between bromide and conductivity and indicated that a higher influent conductivity could be tolerated without increasing bromide concentrations.
- Increased the Ozone LRV-Virus Alarm value from 100% to 110% of the LRV goal (virus LRV = 3.3). This change was made to ensure that the Giardia LRV is maintained > 1.5 .
- Decreased the alert and alarm values for Tasting System Total Ammonia once the biofilters were fully acclimated and nitrifying, and breakpoint chlorination was no longer needed. This CCP ensures free chlorination in the tasting system chlorine contact pipeline.

Parameter	Alert Value	Alarm Value	Unit	Action
Critical Control Points (CCPs)				
Influent Pump Station Conductivity	~~1,200~~1,500	~~1,500~~1,800	microSiemens per centimeter	Place Biofilters in Filter To Waste
Influent Pump Station Total Inorganic Nitrogen	4.0	5.0	mg/L-N	Place Biofilters in Filter To Waste
Influent Pump Station Turbidity	3.5	5.0	NTU	Place Biofilters in Filter To Waste
Preformed Chloramine Failure on Injection	N/A	Failure	mg/L	Divert SWIFT Water
Total Chlorine Post Injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Chloramine injection upstream of ozone	2.0	1.0	mg/L	Divert SWIFT Water
Ozone Feed	N/A	Failure	N/A	Open Biofilter Backwash Waste Valve
Ozone Contactor Calculated LRV – Virus	<120% LRV Goal	~~<100%~~<110% LRV Goal	%	Open Biofilter Backwash Waste Valve
Biofilter Individual Effluent Turbidity	0.1	0.15	NTU	Place That Biofilter in Filter To Waste
Biofilter Combined Filter Effluent Turbidity	0.1	0.15	NTU	Place Biofilters in Filter To Waste
GAC Combined Effluent TOC, instantaneous online analyzer	4.0	5.0	mg/L	Divert SWIFT Water
UV Reactor Dose	<120% of Dose Setpoint	<105% of Dose Setpoint	%	Divert SWIFT Water

Parameter	Alert Value	Alarm Value	Unit	Action
Free Chlorine CT ***(This CCP is not being used since free chlorination of the SWIFT Water is not currently being practiced)***	<120% of CT Target	<105% of CT Target	%	Divert SWIFT Water
GAC Combined Effluent Nitrite	0.25	0.50	mg/L-N	Divert SWIFT Water
SWIFT Water TN	4.5	5.0	mg/L-N	Divert SWIFT Water
Ozone dose	70	80	lbs/day	Place Biofilters in Filter To Waste
Tasting System Free Chlorine CT	<110% of Required CT	<100% of Required CT	mg-min/L	Shut Down Tasting System
Tasting System Total Ammonia	~~10~~ 0.1	~~10~~ 0.3	mg/L-N	Shut Down Tasting System

Table 5. Critical Control Points for the SWIFTRC

					July			August			September		
Parameter	**Units**	**Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values**	**Minimum Report Level[1]**	**Required Monitoring Frequency**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	**3.83**	**5.85**	**28**	**3.82**	**5.09**	**28**	**3.95**	**5.45**	**24**
NO_3	mg/L	10	0.01	Daily[3]	**3.05**	**4.76**	**28**	**3.11**	**4.44**	**28**	**3.12**	**4.71**	**23**
NO_2	mg/L	1	0.01	Daily[3]	**<0.01**	**0.02**	**28**	**0.01**	**0.07**	**28**	**0.01**	**0.07**	**23**
Turbidity	NTU	NA	0.01	Continuous									
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	**3.37**	**3.71**	**12**	**3.27**	**3.81**	**13**	**2.85**	**3.25**	**12**
pH		NA	NA	Continuous									
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**875**	**1**		**782**	**1**		**808**	**1**
Microorganisms													
Total Coliform[5]	MPN/100 mL	MCLG = 0	1	Daily[3]	**<1**	**<1**	**27**	**<1**	**1**	**28**	**<1**	**<1**	**23**
E. coli	MPN/100 mL	NA	1	Weekly	**<1**	**<1**	**27**	**<1**	**<1**	**28**	**<1**	**<1**	**23**
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**2.82**	**1**		**3.66**	**1**		**4.47**	**1**
Trihalomethanes [6]													
Bromodichloromethane	µg/L		1	Monthly		**1.1**	**1**		**<1**	**1**		**<1**	**1**
Bromoform	µg/L		1	Monthly		**5.6**	**1**		**<1**	**1**		**<1**	**1**
Chloroform	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Dibromochloromethane	µg/L		1	Monthly		**3.4**	**1**		**<1**	**1**		**<1**	**1**
Total Trihalomethanes	µg/L	80				**10.1**							
HAAs [6]													
Dichloroacetic acid	µg/L		0.60	Monthly		**1.65**	**1**		**1.83**	**1**		**1.70**	**1**
Trichloroacetic acid	µg/L		0.20	Monthly		**0.39**	**1**		**0.85**	**1**		**0.78**	**1**
Monochloroacetic acid	µg/L		0.60	Monthly		**<0.6**	**1**		**<0.6**	**1**		**<0.6**	**1**
Bromoacetic acid	µg/L		0.40	Monthly		**1.06**	**1**		**<0.4**	**1**		**<0.4**	**1**
Dibromoacetic acid	µg/L		0.20	Monthly		**10.3**	**1**		**0.33**	**1**		**1.16**	**1**
Total Haloacetic Acids	µg/L	60				**13.4**			**3.01**			**3.64**	
Disinfectants													
Monochloramine (as Cl_2) [7]	mg/L	4		Continuous	**0.48**	**1.5**		**0.38**	**0.92**		**0.77**	**1.37**	
Chlorine (as Cl_2) [7]	mg/L	4		Continuous	**0.63**	**3.29**		**0.39**	**0.81**		**0.79**	**1.29**	
Inorganic Chemical													
Barium	mg/L	2	0.005	Monthly		**0.012**	**1**		**0.006**	**1**		**0.007**	**1**
Fluoride	mg/L	4.0	0.05	Monthly	**1.04**	**1.22**	**28**	**1.02**	**1.11**	**28**	**1.03**	**1.29**	**23**

					July			August			September		
Parameter	**Units**	**Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values**	**Minimum Report Level[1]**	**Required Monitoring Frequency**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**
Organic Chemicals													
Acrylamide[8]	µg/L	Treatment Technique, MCLG = 0	0.1	Monthly		**0.13**	**1**		**<0.1**	**1**		**<0.1**	**1**
Radionuclides													
Alpha particles	pCi/L	15	3	Monthly		**7.7**	**1**		**<3**	**1**		**<3**	**1**
Beta particles and photon emitters	pCi/L	4 mrem/yr[9]	3	Monthly		**20**	**1**		**16**	**1**		**19**	**1**
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.47**	**0.50**	**4**	**0.38**	**0.44**	**4**	**0.40**	**0.49**	**4**
NDMA	ng/L	10	2	Quarterly	**2.65**	**8.34**	**5**	**5.43**	**6.93**	**4**	**2.80**	**3.42**	**4**
Perchlorate	µg/L	6	0.50	Quarterly		**0.52**	**1**						
Treatment Efficacy Indicators		**Trigger Limits**											
Sucralose	ng/L	150,000,000	100	Quarterly		**270**	**1**						
Additional Monitoring (Ozone & UV LRV)					**Average**	**Minimum**		**Average**	**Minimum**		**Average**	**Minimum**	
Ozone Virus LRV				Continuous	**4.53**	**3.07**		**4.51**	**3.41**		**4.51**	**3.56**	
Ozone Giardia LRV[10]				Continuous	**2.11**	**1.44**		**2.1**	**1.59**		**2.11**	**1.66**	
UV Dose Reactor 1	mJ/cm^2			Continuous	**>186**	**>186**		**>186**	**>186**		**>186**	**>186**	
UV Virus LRV Reactor 1				Continuous	**>4**	**>4**		**>4**	**>4**		**>4**	**>4**	
UV Dose Reactor 2	mJ/cm^2			Continuous	**>186**	**>186**		**>186**	**>186**		**>186**	**>186**	
UV Virus LRV Reactor 2				Continuous	**>4**	**>4**		**>4**	**>4**		**>4**	**>4**	

[1] When minimum reporting limits varied during the quarter, the highest minumum reporting limit used is identified.

[2] Analytical results less than the reporting limit were treated as zero for the purposes of the averaging calculation.

[3] Daily samples are typically not collected on days in which there is no or limited recharge. Limited or inconsistent recharge impacts the collection of daily samples, particularly for the microbiological samples collected for total coliform and e coli which have limited holding time requirements. Recharge occurred on 28 days in July, 30 days in August, and 26 days in September. We identified a single day in September in which daily samples should have been collected but were not due to operator error. This has been addressed through retraining.

[4] TDS of the Potomac Aquifer System is based on the averages within the upper, middle and lower Potomac Aquifer as determined during baseline montioring.

[5] A positive TC result was documented on August 12 with a result of 1 CFU/100 mL. E coli were absent.

[6] Though still well below the MCLs for Total Trihalomethanes and Haloacetic Acids, note that the July concentrations for these disinfection by-products were higher than August and September due to the use of free chlorination to control nitrite formation. Once the biofilters were fully acclimated and nitrifying, we returned to adding a small amount of monochloramine to the SWIFT Water prior to recharge to prevent biofouling of the well.

[7] The maximum residual disinfectant level (or MRDL) MCL for monochloramine and chlorine are based on annual averages.

[8] Acrylamide: The July 2 sampling event resulted quantifiable result for acrylamide. The MCL for acrylamide is a treatment technique designed to reduce the level of the contaminant in water. After the November 2018 detection of acrylamide, HRSD evaluated its dosing within the wastewater system to determine the potential for thickening and dewatering organic polyelectrolytes to contribute to the detection seen in SWIFT Water. It was determined that organic polyelectrolytes used onsite at Nansemond are not a significant source of acrylamide even in a worst case condition. This led us to further evaluate the regulated industrial discharge of an acrylamide manufacturer located within the Nansemond service area. Monitoring of the industrial discharge from this facility identified it as the primary source of the acrylamide load to the Nansemond Plant. HRSD's Pretreatment and Pollution Prevention division is working with the industry on a management strategy for the waste material.

[9] The measurement unit for beta particles and photon emitters is pCi/L while the MCL is expressed as mrem/yr. Per EPA's Implementation Guidance for Radionuclides (EPA 816-F-00-002, March 2002), the screening threshold for beta particles and photon emitters is 50 pCi/L. If sample concentrations exceed 50 pCi/L, each individual beta particle and photon emitter is converted from pCi/L to mrem using the EPA designated conversion tables, currently available in the referenced document.

[10] The minimum ozone Giardia LRV was less than 1.5 on July 18, 2019. The minimum LRV of 1.5 is necessary for operation of the tasting system since there is no added LRV benefit from soil aquifer treatment. The tasting system was not operated on this day. As indicated in Part 1, the virus LRV CCP alarm value has been increased to avoid this concern in the future.

Recharge Statistics

The total volume recharged during this operational period was 50.1 million gallons. 2.4 million gallons was backflushed for a net recharge of 47.7 million gallons (Figure 3). Brief backflushing periods occur as part of routine well maintenance on an approximate daily basis.

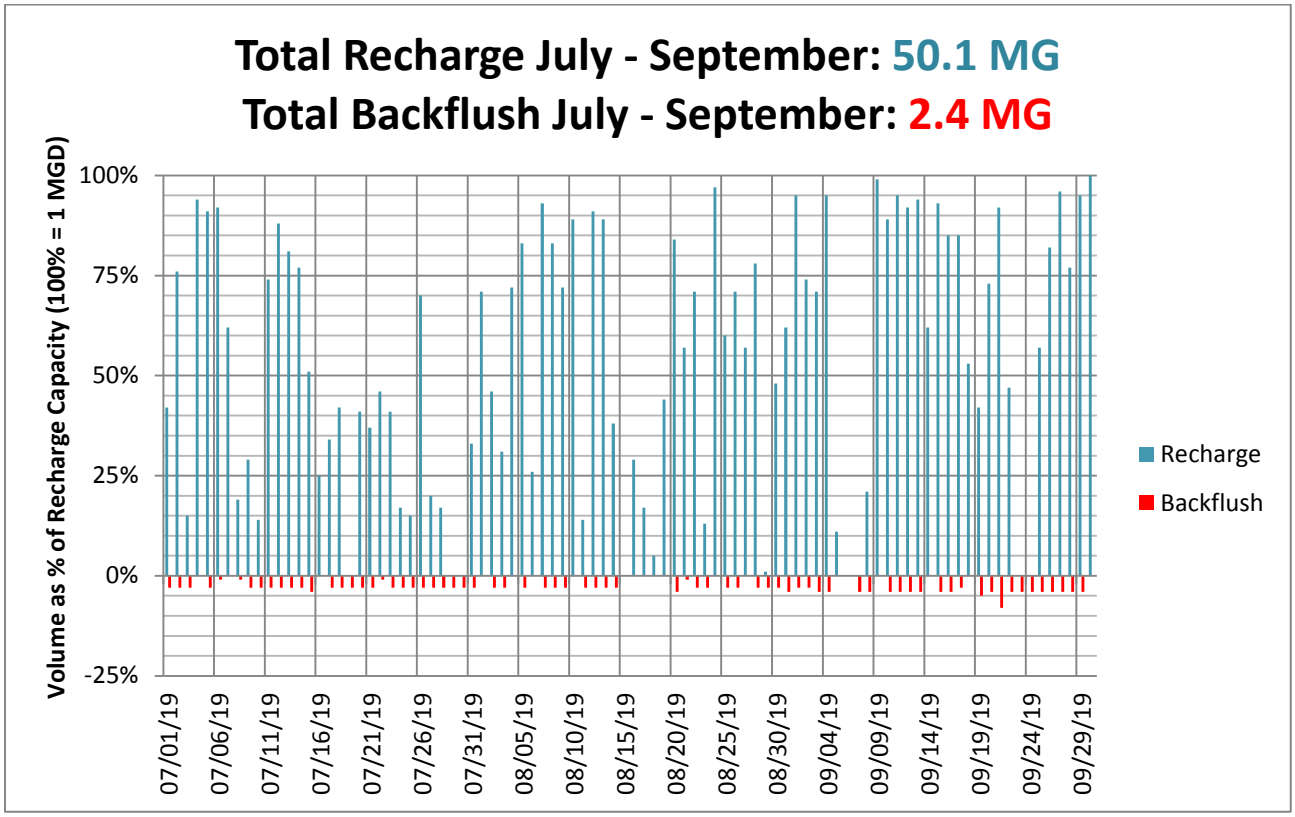

Figure 3: Recharge and Backflush Volumes, July 1 – September 30, 2019.

Nitrite in MW-SAT Update

HRSD continues to monitor nitrite levels within MW-SAT and the conventional wells to better understand the occurrence of in situ partial denitrification and the potential for nitrite migration with the recharge front. Nitrite has remained well below the MCL within the monitoring intervals of MW-SAT (Figures 4-5). The recharge front has not yet been detected at the conventional wells and there is no observable increase in nitrite or nitrate at the conventional monitoring wells (Figure 6). Monitoring for nitrate and nitrite at MW-SAT is occurring a minimum of twice monthly in each of the screen intervals. Monitoring is conducted monthly at the conventional wells. More frequent monitoring will be implemented as needed based on the movement of the recharge front and data trends.

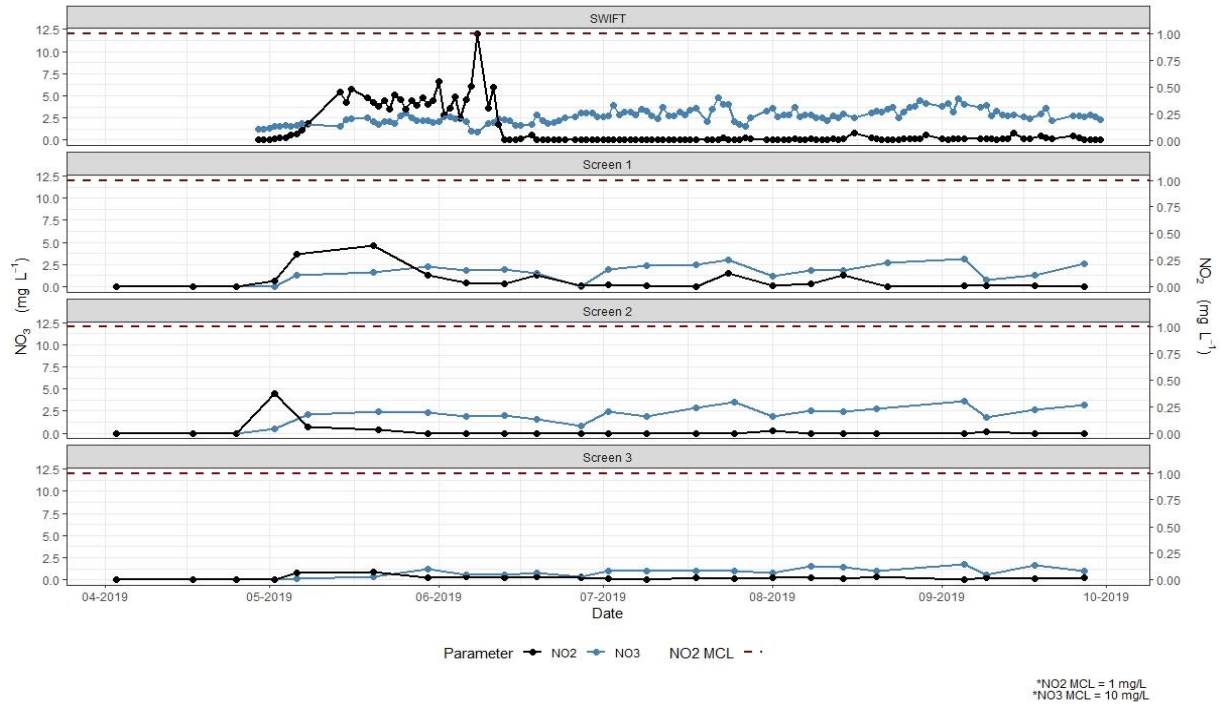

Figure 4: Average Daily Nitrite and Nitrate Concentrations in MW-SAT Screen Intervals 1, 2 and 3 relative to the nitrite PMCL and SWIFT Water concentrations (SWIFT). Recharge was not occurring on June 8, 2019 when nitrite was 1.00 mg/L.

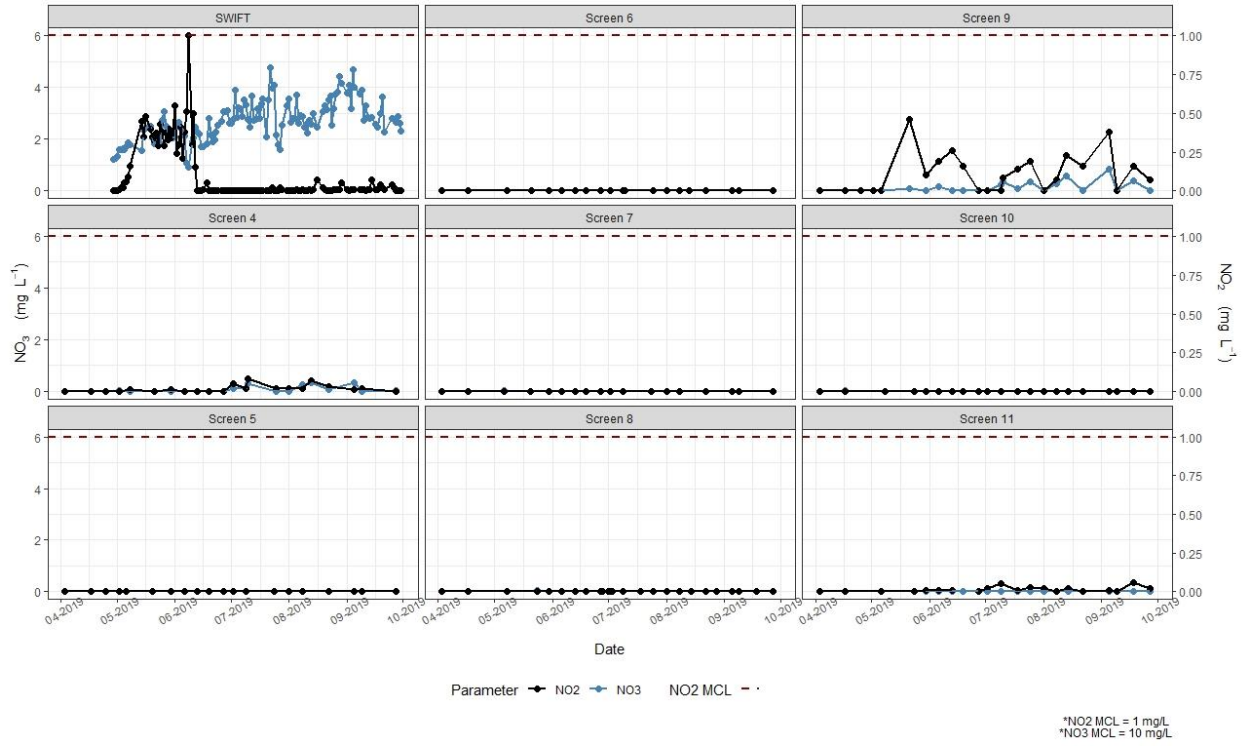

Figure 5: Average Daily Nitrite Concentration in MW-SAT Screen Intervals 4 - 11 (S4-S11) relative to the nitrite PMCL and SWIFT Water concentrations (SWIFT).

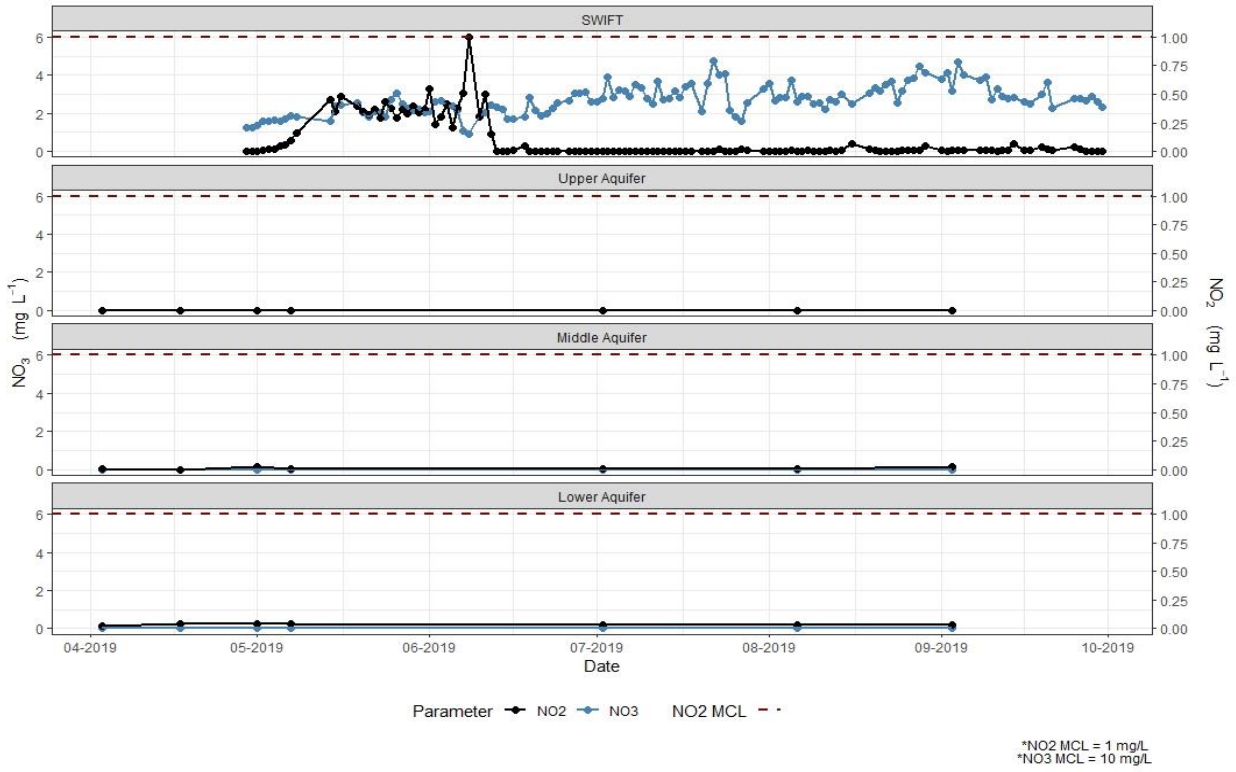

Figure 6: Average Daily Nitrite Concentration in the conventional monitoring wells (MW-UPA, MW-MPA, MW-LPA).

Arsenic in MW-SAT Update

As described in a brief report issued on May 16, 2019, the concentration of arsenic in MW-SAT screen interval 9 increased above the MCL of 10 µg/L in a sample collected on May 6, eight days after resuming recharge. Analysis of both total and dissolved arsenic indicated that the arsenic was present primarily as dissolved. Continued monitoring of screen interval 9 has documented a continued decrease in total arsenic concentration. The last observed total arsenic concentration greater than 3 µg/L was observed August 3, 2019 with a result of 3.10 µg/L (Figure 7).

The arsenic concentration in the remaining screen intervals of MW-SAT remained less than 3 µg/L since the July 9. Only two screen intervals had a documented concentration of arsenic > 3 µg/L during this quarterly monitoring period: screen interval 2 with 3.97 and 3.39 µg/L on July 2 and July 9, respectively, and screen interval 5 with 3.19 µg/L on July 2. The arsenic concentration in the conventional wells of the lower, middle and upper Potomac Aquifer remained less than 1 µg/L (Figure 8) during this period. Arsenic monitoring will continue weekly in all screen intervals receiving recharge and in the conventional monitoring wells.

As discussed in the previous report, while monitoring is on-going in MW-SAT and the conventional wells, HRSD initiated a study on arsenic mobility using the soil test columns that were developed to evaluate the availability of additional soil aquifer treatment within the Potomac Aquifer System. These test columns are designed to simulate 3 day, 1 month and 6 month travel times for recharge water. The results of this additional work will be provided when available.

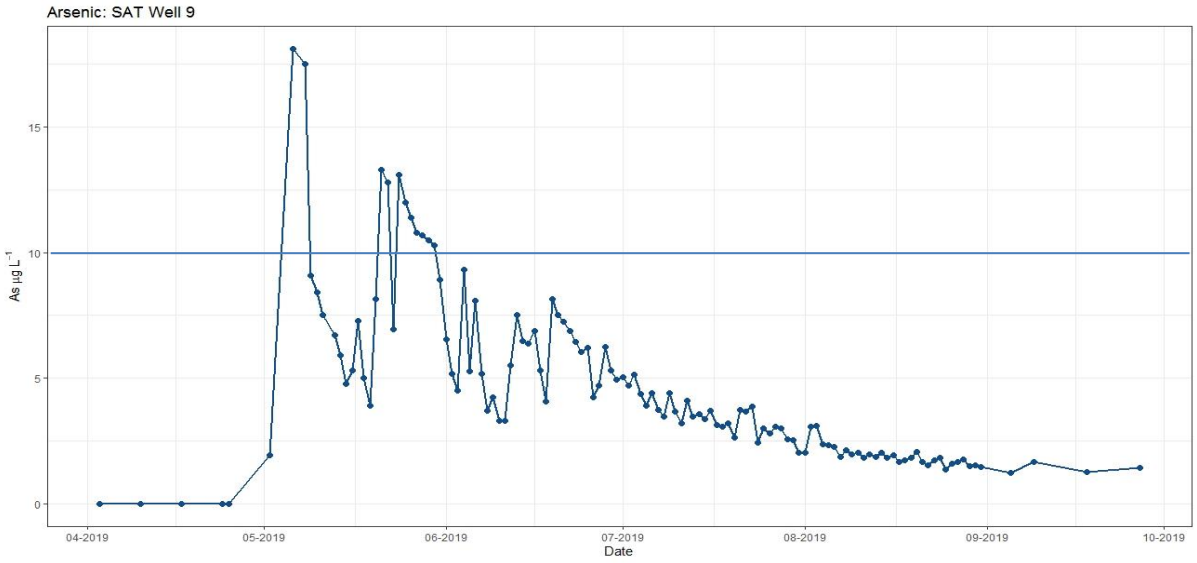

Figure 7: Total arsenic concentrations in Screen Interval 9. The MCL of 10 µg/L is noted by the blue horizontal bar.

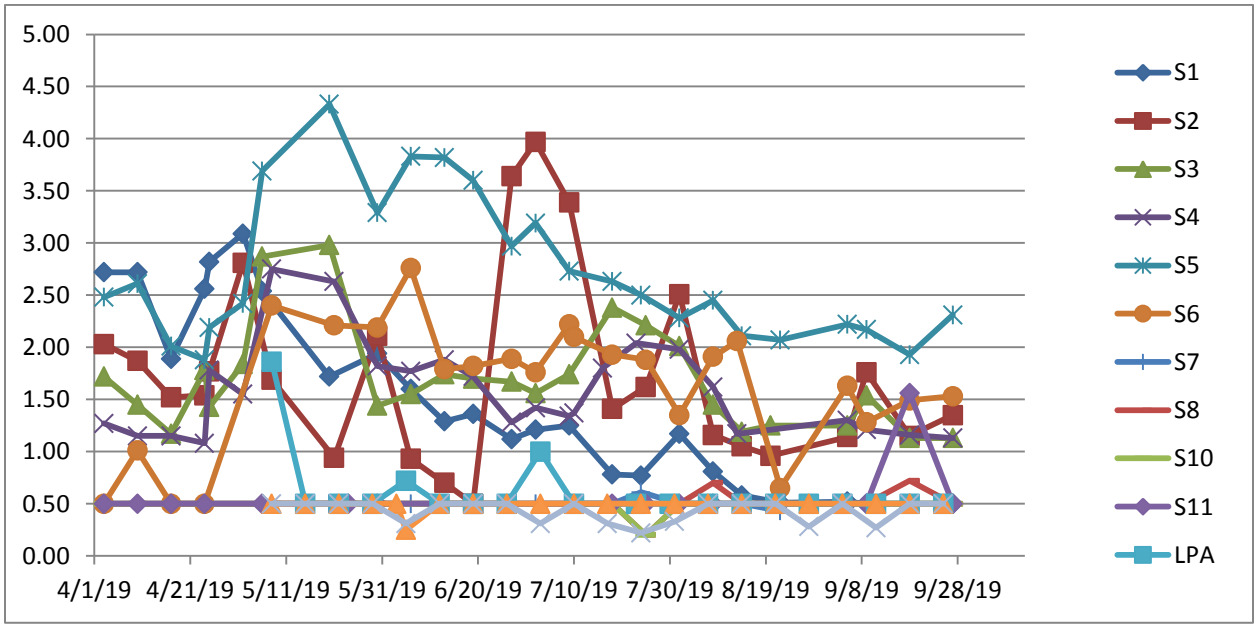

Figure 8: Arsenic concentration in MW-SAT intervals (excluding interval 9) and the conventional wells (Lower Potomac Aquifer - LPA, Middle Potomac Aquifer - MPA, and Upper Potomac Aquifer - UPA).

Appendix

Monitoring Data for SWIFT Water Quality Regulatory Targets

					July			August			September		
Parameter	**Units**	**Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values**	**Minimum Report Level[1]**	**Required Monitoring Frequency**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**
Regulatory Parameters													
Total Nitrogen (TN)	mg/L	NA	0.50	Daily[3]	**3.83**	**5.85**	**28**	**3.82**	**5.09**	**28**	**3.95**	**5.45**	**24**
NO_3	mg/L	10	0.01	Daily[3]	**3.05**	**4.76**	**28**	**3.11**	**4.44**	**28**	**3.12**	**4.71**	**23**
NO_2	mg/L	1	0.01	Daily[3]	**<0.01**	**0.02**	**28**	**0.01**	**0.07**	**28**	**0.01**	**0.07**	**23**
Turbidity	NTU	NA	0.01	Continuous									
Total Organic Carbon (TOC)	mg/L	NA	1.00	3x/Wk[3]	**3.37**	**3.71**	**12**	**3.27**	**3.81**	**13**	**2.85**	**3.25**	**12**
pH		NA	NA	Continuous									
TDS[4]	mg/L	Potomac Aquifer System Range: 694-8,720	2.5	Monthly		**875**	**1**		**782**	**1**		**808**	**1**
Microorganisms													
Total Coliform[5]	MPN/100 mL	MCLG = 0	1	Daily[3]	**<1**	**<1**	**27**	**<1**	**1**	**28**	**<1**	**<1**	**23**
E. coli	MPN/100 mL	NA	1	Weekly	**<1**	**<1**	**27**	**<1**	**<1**	**28**	**<1**	**<1**	**23**
Cryptosporidium	oocysts/L	Treatment Technique, MCLG = 0	0.095	Quarterly		**<0.095**	**1**						
Giardia lamblia	oocysts/L	Treatment Technique, MCLG = 0	0.095	Quarterly		**<0.095**	**1**						
Legionella	MPN/100 mL	Treatment Technique, MCLG = 0	10	Quarterly		**<10**	**1**						
Disinfection Byproducts													
Bromate	µg/L	10	0.15	Monthly		**2.82**	**1**		**3.66**	**1**		**4.47**	**1**
Chlorite	mg/L	1.0	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Trihalomethanes[6]													
Bromodichloromethane	µg/L		1	Monthly		**1.1**	**1**		**<1**	**1**		**<1**	**1**
Bromoform	µg/L		1	Monthly		**5.6**	**1**		**<1**	**1**		**<1**	**1**
Chloroform	µg/L		1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Dibromochloromethane	µg/L		1	Monthly		**3.4**	**1**		**<1**	**1**		**<1**	**1**
Total Trihalomethanes	µg/L	80				**10.1**							
HAAs[6]													
Dichloroacetic acid	µg/L		0.60	Monthly		**1.65**	**1**		**1.83**	**1**		**1.70**	**1**
Trichloroacetic acid	µg/L		0.20	Monthly		**0.39**	**1**		**0.85**	**1**		**0.78**	**1**
Monochloroacetic acid	µg/L		0.60	Monthly		**<0.6**	**1**		**<0.6**	**1**		**<0.6**	**1**
Bromoacetic acid	µg/L		0.40	Monthly		**1.06**	**1**		**<0.4**	**1**		**<0.4**	**1**
Dibromoacetic acid	µg/L		0.20	Monthly		**10.3**	**1**		**0.33**	**1**		**1.16**	**1**
Total Haloacetic Acids	µg/L	60				**13.4**			**3.01**			**3.64**	

Appendix

Monitoring Data for SWIFT Water Quality Regulatory Targets

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	July			August			September		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Disinfectants													
Monochloramine (as Cl_2) [7]	mg/L	4		Continuous	0.48	1.5		0.38	0.92		0.77	1.37	
Chlorine (as Cl_2) [7]	mg/L	4		Continuous	0.63	3.29		0.39	0.81		0.79	1.29	
Inorganic Chemical													
Antimony	µg/L	6	2.5	Monthly		<2.5	1	<2.5	<2.5	2		<2.5	1
Arsenic	µg/L	10	1	Monthly		<1	1	<1	<1	2		<1	1
Asbestos	MFL	7	0.2	Monthly		<0.2	1		<0.2	1		<0.2	1
Barium	mg/L	2	0.005	Monthly		0.012	1		0.006	1		0.007	1
Beryllium	µg/L	4	0.1	Monthly		<0.1	1	<0.1	<0.1	2		<0.1	1
Cadmium	µg/L	5	0.1	Monthly		<0.1	1	<0.1	<0.1	2		<0.1	1
Chromium (total)	µg/L	100	5	Monthly		<5	1	<5	<5	2		<5	1
Copper	mg/L	1.3 (action level)	0.005	Monthly		<0.005	1		<0.005	1		<0.005	1
Cyanide (total)	µg/L	200	10	Monthly		<10	1		<10	1		<10	1
Fluoride	mg/L	4.0	0.05	Monthly	1.04	1.22	28	1.02	1.11	28	1.03	1.29	23
Lead	µg/L	15 (action level)	0.1	Monthly		<0.1	1	<0.1	<0.1	2		<0.1	1
Mercury	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Selenium	µg/L	50	5	Monthly		<5	1	<5	<5	2		<5	1
Thallium	µg/L	2	0.1	Monthly		<0.1	1	<0.1	<0.1	2		<0.1	1
Organic Chemicals													
Acrylamide[8]	µg/L	Treatment Technique, MCLG = 0	0.1	Monthly		0.13	1		<0.1	1		<0.1	1
Alachlor	µg/L	2	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Atrazine	µg/L	3	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Benzo(a)pyrene (PAHs)	µg/L	0.2	0.02	Monthly		<0.02	1		<0.02	1		<0.02	1
Di(2-ethylhexyl) adipate	µg/L	400	0.6	Monthly		<0.6	1		<0.6	1		<0.6	1
Di(2-ethylhexyl) phthalate	µg/L	6	0.6	Monthly		<0.6	1		<0.6	1		<0.6	1
Hexachlorocyclopentadiene	µg/L	50	0.05	Monthly		<0.05	1		<0.05	1		<0.05, LE	1
Hexachlorobenzene	µg/L	1	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Simazine	µg/L	4	0.05	Monthly		<0.05	1		<0.05	1		<0.05	1
Carbofuran	µg/L	40	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
Oxamyl (Vydate)	µg/L	200	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1
Chlordane	µg/L	2	0.1	Monthly		<0.1	1		<0.1	1		<0.1	1
Endrin	µg/L	2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Heptachlor	µg/L	0.4	0.01	Monthly		<0.01, V1	1		<0.01	1		<0.01	1
Heptachlor Epoxide	µg/L	0.2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Lindane	µg/L	0.2	0.01	Monthly		<0.01	1		<0.01	1		<0.01	1
Methoxychlor	µg/L	40	0.05	Monthly		<0.05, V1	1		<0.05	1		<0.05	1
Toxaphene	µg/L	3	0.5	Monthly		<0.5	1		<0.5	1		<0.5	1

					July			August			September		
Parameter	**Units**	**Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values**	**Minimum Report Level[1]**	**Required Monitoring Frequency**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**
PCB Arochlor1016	µg/L		0.08	Monthly		**<0.08**	**1**		**<0.08**	**1**		**<0.08**	**1**
PCB Arochlor1221	µg/L		0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
PCB Arochlor1232	µg/L		0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
PCB Arochlor1242	µg/L		0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
PCB Arochlor1248	µg/L		0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
PCB Arochlor1254	µg/L		0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
PCB Arochlor1260	µg/L		0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Total Polychlorinated Biphenyls (PCBs)	µg/L	0.5											
2,4-D	µg/L	70	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
Dalapon	µg/L	200	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Picloram	µg/L	500	0.1	Monthly		**<0.1**	**1**		**<0.1**	**1**		**<0.1**	**1**
2,4,5-TP (Silvex)	µg/L	50	0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**
Dinoseb	µg/L	7	0.2	Monthly		**<0.2**	**1**		**<0.2**	**1**		**<0.2**	**1**
Pentachlorophenol	µg/L	1	0.04	Monthly		**<0.04**	**1**		**<0.04**	**1**		**<0.04**	**1**
Dioxin (2,3,7,8-TCDD)	pg/L	30	5	Monthly		**<5**	**1**		**<5**	**1**		**<5**	**1**
Diquat	µg/L	20	0.4	Monthly		**<0.4**	**1**		**<0.4**	**1**		**<0.4**	**1**
Endothall	µg/L	100	5	Monthly		**<5**	**1**		**<5**	**1**		**<5**	**1**
Epichlorohydrin	µg/L	Treatment Technique, MCLG = 0	0.4	Monthly		**<0.4**	**1**		**<0.4**	**1**		**<0.4**	**1**
Glycophosphate	µg/L	700	6	Monthly		**<6**	**1**		**<6**	**1**		**<6**	**1**
Benzene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Carbon Tetrachloride	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Chlorobenzene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-dibromo-3-chloropropane (DBCP)	µg/L	0.2	0.02	Monthly		**<0.02**	**1**		**<0.02**	**1**		**<0.02**	**1**
o-Dichlororbenzene	µg/L	600	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
p-Dichlorobenzene	µg/L	75	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-Dichloroethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1-Dichlororethylene	µg/L	7	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
cis-1,2-Dichloroehtylene	µg/L	70	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
trans-1,2-Dichloroethylene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Dichloromethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,2-Dichloropropane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Ethylbenzene	µg/L	700	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Ethylene Dibromide (EDB)	µg/L	0.05	0.02	Monthly		**<0.02**	**1**		**<0.02**	**1**		**<0.02**	**1**
Styrene	µg/L	100	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Tetrachloroethylene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Toluene	µg/L	1,000	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**

					July			August			September		
Parameter	**Units**	**Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values**	**Minimum Report Level[1]**	**Required Monitoring Frequency**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**	**Average[2]**	**Maximum**	**Numer of Samples**
1,2,4-Trichlorobenzene	µg/L	70	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1,1-Trichloroethane	µg/L	200	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
1,1,2-Trichloroethane	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Trichloroethylene	µg/L	5	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Vinyl Chloride	µg/L	2	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Total Xylene	µg/L	10,000	3	Monthly		**<3**	**1**		**<3**	**1**		**<3**	**1**
Radionuclides													
Alpha particles	pCi/L	15	3	Monthly		**7.7**	**1**		**<3**	**1**		**<3**	**1**
Beta particles and photon emitters	pCi/L	4 mrem/yr[9]	3	Monthly		**20**	**1**		**16**	**1**		**19**	**1**
Radium 226	pCi/L	5 (226+228)	1	Monthly		**<1**	**1**		**<1**	**1**		**<1**	**1**
Radium 228	pCi/L	5 (226+228)	1	Monthly		**<1, L5**	**1**		**<1**	**1**		**<1**	**1**
Uranium	µg/L	30	0.1	Monthly		**<0.1**	**1**	**<0.1**	**<0.1**	**2**		**<0.1**	**1**
Strontium-90	pCi/L	NA	0.580*	Monthly		**<0.580**	**1**		**<0.580**	**1**		**<0.580**	**1**
Tritium	pCi/L	NA	1000*	Monthly		**<1000**	**1**		**<1000**	**1**		**<1000**	**1**
Non-regulatory Performance Indicators													
Public Health Indicators		**Trigger Limits**											
1,4-dioxane	µg/L	1	0.06	Quarterly	**0.47**	**0.50**	**4**	**0.38**	**0.44**	**4**	**0.40**	**0.49**	**4**
17-β-estradiol	ng/L	TBD	0.0004	Quarterly								**<0.0004**	**1**
DEET	ng/L	200,000	10	Quarterly		**<10**	**1**						
Ethinyl estradiol	ng/L	TBD	10	Quarterly		**<10**	**1**						
Tris(2-carboxyethyl)phosphine (TCEP)	ng/L	5,000	10	Quarterly		**<10**	**1**						
NDMA	ng/L	10	2	Quarterly	**2.65**	**8.34**	**5**	**5.43**	**6.93**	**4**	**2.80**	**3.42**	**4**
Perchlorate	µg/L	6	0.50	Quarterly		**0.52**	**1**						
Perfluorooctanoic Acid (PFOA)	µg/L	0.070 (PFOA+PFOS)	0.002	Quarterly								**<0.002**	**1**
Perfluorooctanesulfonic Acid (PFOS)	µg/L	0.070 (PFOA+PFOS)	0.002	Quarterly								**<0.002**	**1**
Treatment Efficacy Indicators		**Trigger Limits**											
Cotinine	ng/L	1,000	10	Quarterly		**<10**	**1**						
Primidone	ng/L	10,000	5	Quarterly		**<5**	**1**						
Phenytoin (Dilantin)	ng/L	2,000	20	Quarterly		**<20**	**1**						
Meprobamate	ng/L	200,000	5	Quarterly		**<5**	**1**						
Atenolol	ng/L	4,000	5	Quarterly		**<5**	**1**						
Carbemazepine	ng/L	10,000	5	Quarterly		**<5**	**1**						
Estrone	ng/L	320,000	10	Quarterly		**<10**	**1**						
Sucralose	ng/L	150,000,000	100	Quarterly		**270**	**1**						
Triclosan	ng/L	210,000	20	Quarterly		**<20**	**1**						

Appendix

Monitoring Data for SWIFT Water Quality Regulatory Targets

Parameter	Units	Maximum Contaminant Level (MCL) or MCL Goal (MCLG) where numerical MCL not expressed. Values noted for indicator compounds are non-regulatory screening values	Minimum Report Level[1]	Required Monitoring Frequency	July			August			September		
					Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples	Average[2]	Maximum	Numer of Samples
Additional Monitoring (Ozone & UV LRV)					Average	Minimum		Average	Minimum		Average	Minimum	
Ozone Virus LRV				Continuous	4.53	3.07		4.51	3.41		4.51	3.56	
Ozone Giardia LRV[10]				Continuous	2.11	1.44		2.1	1.59		2.11	1.66	
UV Dose Reactor 1	mJ/cm^2			Continuous	>186	>186		>186	>186		>186	>186	
UV Virus LRV Reactor 1				Continuous	>4	>4		>4	>4		>4	>4	
UV Dose Reactor 2	mJ/cm^2			Continuous	>186	>186		>186	>186		>186	>186	
UV Virus LRV Reactor 2				Continuous	>4	>4		>4	>4		>4	>4	

[1] When minimum reporting limits varied during the quarter, the highest minumum reporting limit used is identified.

[2] Analytical results less than the reporting limit were treated as zero for the purposes of the averaging calculation.

[3] Daily samples are typically not collected on days in which there is no or limited recharge. Limited or inconsistent recharge impacts the collection of daily samples, particularly for the microbiological samples collected for total coliform and e coli which have limited holding time requirements. Recharge occurred on 28 days in July, 30 days in August, and 26 days in September. We identified a single day in September in which daily samples should have been collected but were not due to operator error. This has been addressed through retraining.

[4] TDS of the Potomac Aquifer System is based on the averages within the upper, middle and lower Potomac Aquifer as determined during baseline montioring.

[5] A positive TC result was documented on August 12 with a result of 1 CFU/100 mL. E coli were absent.

[6] Though still well below the MCLs for Total Trihalomethanes and Haloacetic Acids, note that the July concentrations for these disinfection by-products were higher than August and September due to the use of free chlorination to control nitrite formation. Once the biofilters were fully acclimated and nitrifying, we returned to adding a small amount of monochloramine to the SWIFT Water prior to recharge to prevent biofouling of the well.

[7] The maximum residual disinfectant level (or MRDL) MCL for monochloramine and chlorine are based on annual averages.

[8] Acrylamide: The July 2 sampling event resulted quantifiable result for acrylamide. The MCL for acrylamide is a treatment technique designed to reduce the level of the contaminant in water. After the November 2018 detection of acrylamide, HRSD evaluated its dosing within the wastewater system to determine the potential for thickening and dewatering organic polyelectrolytes to contribute to the detection seen in SWIFT Water. It was determined that organic polyelectrolytes used onsite at Nansemond are not a significant source of acrylamide even in a worst case condition. This led us to further evaluate the regulated industrial discharge of an acrylamide manufacturer located within the Nansemond service area. Monitoring of the industrial discharge from this facility identified it as the primary source of the acrylamide load to the Nansemond Plant. HRSD's Pretreatment and Pollution Prevention division is working with the industry on a management strategy for the waste material.

[9] The measurement unit for beta particles and photon emitters is pCi/L while the MCL is expressed as mrem/yr. Per EPA's Implementation Guidance for Radionuclides (EPA 816-F-00-002, March 2002), the screening threshold for beta particles and photon emitters is 50 pCi/L. If sample concentrations exceed 50 pCi/L, each individual beta particle and photon emitter is converted from pCi/L to mrem using the EPA designated conversion tables, currently available in the referenced document.

[10] The minimum ozone Giardia LRV was less than 1.5 on July 18, 2019. The minimum LRV of 1.5 is necessary for operation of the tasting system since there is no added LRV benefit from soil aquifer treatment. The tasting system was not operated on this day. As indicated in Part 1, the virus LRV CCP alarm value has been increased to avoid this concern in the future.

Contract Laboratory Flags

(V1) - CCV recovery was above method acceptance limits. This target analyte was not detected in the sample.

(L5) - The associated blank spike recovery was above laboratory/method acceptance limits. This analyte was not detected in the sample.

(LE) - MRL Check recovery was above laboratory acceptance limits.